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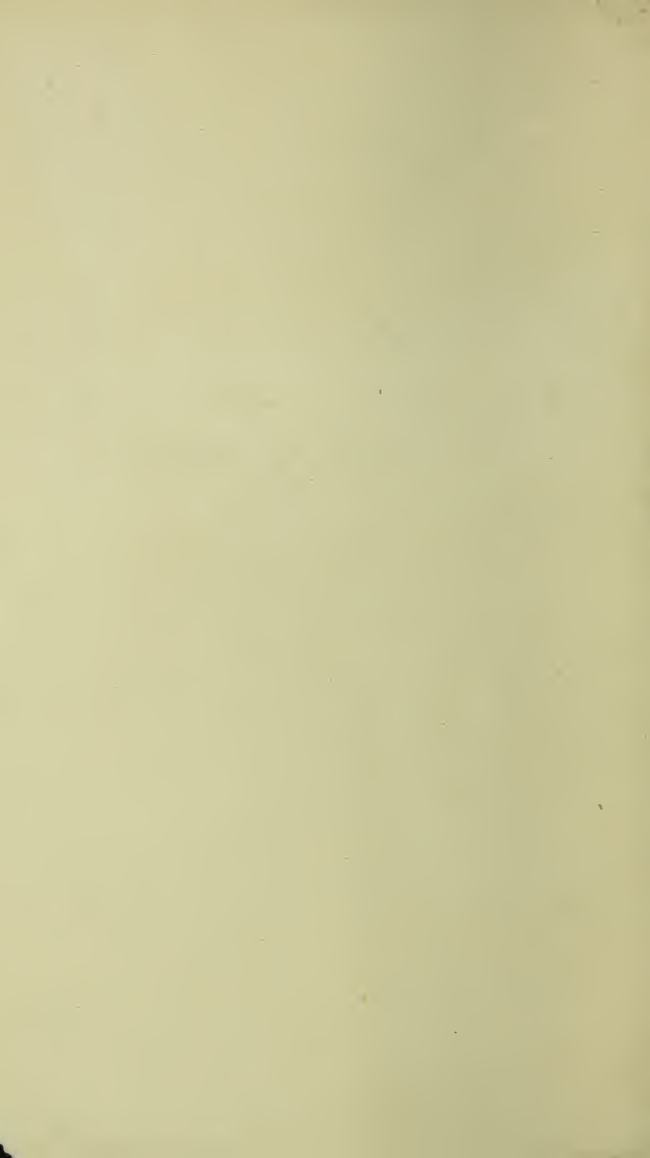
NOTES ON THE
CLINICAL EXAMINATION
OF THE
BLOOD AND EXCRETA

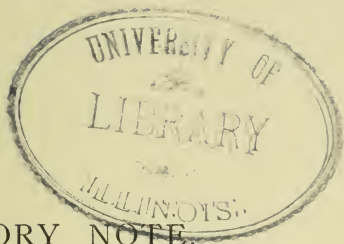
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PREFATORY NOTE.

IN preparing the third edition of this little book I have endeavoured to make it more accurate in certain particulars without changing its character. I am indebted to Professor Tirard for some valuable suggestions in the sections on the Urine; and to my house physician, Mr. E. Hill, for the description of the use of Dr. Johnson's Picro-saccharimeter.

S. C.

LONDON,
October 1892.

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NOTES ON
THE CLINICAL EXAMINATION
OF THE
BLOOD AND EXCRETA.

THE BLOOD.

FOR clinical purposes it is sufficient to examine a drop of blood obtained from a puncture of the finger, which should first be thoroughly cleansed. The puncture should be made with a perfectly clean needle, and, as far as possible, undue pressure of the finger should be avoided.

Reaction.

The degree of alkalinity varies. It may be determined by the use of specially prepared glazed litmus papers, previously treated by varying quantities of oxalic acid (Haycraft and Williamson). A drop of blood is allowed to remain for half a minute on a paper of medium acidity, and is then washed off.

Should it give a reaction, a stronger paper is tested with another drop until the limit is reached. If it gives no reaction, a paper of weaker acidity is taken, and so on.

Specific gravity.

A drop of blood is allowed to fall into tube containing a mixture of glycerine and water. When the mixture is of such a degree of dilution that its specific gravity is the same as that of the blood, the drop of latter will remain suspended in it.

Or the same procedure may be followed in using a mixture of benzol and chloroform; small additions of one or other of these liquids being made until the blood-drop is suspended. The specific gravity of the mixture will then correspond with that of the blood.

Estimation of hæmoglobin.

The percentage amount of hæmoglobin may be approximately arrived at by the use of Gowers' hæmoglobinometer. This consists of a small graduated tube (100 divisions in 2 centimetres), which would, if filled up to that point (100) with 20 cub. mm. of normal blood and distilled water, give a tint corre-

sponding to a standard (composed of glycerine jelly and picrocarmine) kept in a tube of the same calibre.

Method.—From a puncture in the finger there is drawn into a pipette 20 cub. mm. of blood, which is carefully ejected into the graduated tube. To this distilled water is added, and the blood thoroughly mixed with it; as soon as the tint of the diluted blood equals that in the standard tube, no more water is added, and the degree attained will represent the percentage of hæmoglobin in the specimen of blood examined.

[Hæmoglobin diminished in anæmia: in chlorosis, out of proportion to corpuscles.]

Microscopical examination.

1. Red corpuscles.

(a) Note whether rouleaux form speedily.

[In anæmic and hydræmic states there may be no rouleaux.]

(b) *Size.*—Average diameter is $7.5\ \mu$; but variations at different life-periods, and in disease.

[Small spheroidal coloured corpuscles (microcytes), and unusually large forms (megalocytes), met with in anæmia.]

(c) *Shape*.—Considerable variations from the characteristic disc-shape, especially observed in progressive pernicious anæmia and in other chronic conditions. This change (poikilocytosis), depending apparently on undue plasticity of corpuscles, as well as on their disintegration, results in appearance of tailed, pear-shaped, coloured bodies, and other irregular masses and granules.

(d) *Number*.—Estimated by the hæmacytometer, of which there are several forms. The simplest is that of Gowers. It consists of a micrometer scale engraved on a glass slide, and surrounded by a cell $\frac{1}{5}$ mm. in depth. The scale is ruled in squares, each measuring $\frac{1}{10}$ mm. A drop of blood (5 cub. mm.) taken up in a capillary pipette is diluted to 200 times its bulk with saline solution (sulphate of soda, 104 grains, acetic acid, 1 drachm, distilled water, 4 ounces).

Thus, 995 cub. mm. of this solution is placed in a small glass beaker, to which the 5 cub. mm. of blood is added, and the mixture thoroughly stirred. A drop of the diluted blood is placed in the cell, and the number of corpuscles which subside in each square can then be counted.

Count the corpuscles in (at least) 10 squares, and strike the average.

The number of corpuscles per cub. mm. of blood is arrived at by multiplying the average contents of a single square by 100,000.

[For the contents of each square must be multiplied by $(5 \times 5) \times (10 \times 2)$, to be equivalent to 1 cub. mm., and as the blood was diluted 200 times, this must be further multiplied by 200.]

The average number for normal blood is about 5,000,000 per cub. mm., which would give an average in each square of 50, or in every two squares of 100. Hence the contents of two squares will represent the percentage composition in corpuscles as compared with the healthy standard.

[Red corpuscles diminished in all conditions of anæmia. Most markedly after profuse hæmorrhage, and in pernicious anæmia. In the latter affection it is important to make repeated numerations.]

2. *White corpuscles* (leucocytes).

Considerable variation in shape, size, and number in health.

Relative increase in number in anæmia.

Absolute increase in leukhæmia.

Numeration by hæmacytometer may be made at the same time as that of red corpuscles. But, owing to the much smaller number (except in leukhæmia) of the leucocytes, the contents of several squares must be observed.

[A low power may be used, for these bodies are readily recognised by their bright refractile aspect.]

3. *Fibrin, protoplasmic granules, etc.*

In febrile and inflammatory states the microscopic field is speedily covered by a network of fibrin. "Blood platelets," "granular masses," etc., occur in various states, not as yet fully defined.

4. *Crystals.*

Crystals of hæmoglobin have been found in hæmoglobinuria and leukhæmia (Cope-man).

Charcot-Leyden crystals (*see* p. 17) in leukhæmia.

5. *Pigment.*

Free pigment granules (hæmatin) in hæmoglobinuria. Small masses of pigment in melanæmia.

6. *Parasites.*

(a) *Filaria sanguinis hominis*.—Embryos filiform, about 0·35 mm. in length, enter lymphatic and blood stream periodically (during the hours of rest) from the parent-worm, which is usually lodged in the deeper lymphatic channels. Chyluria, lymph-scrotum, elephantiasis, are the usual concomitant conditions, referable to lymphatic obstruction.

(b) *Spirillum of relapsing fever* (Obermeier).

(c) *Bacillus anthracis*.—In malignant pustule and woolsorter's disease.

(d) *Bacillus tuberculosis*.—Rarely detected.

(e) *Streptococci and staphylococci*.—Have been found in erysipelas, pyæmia, scarlet fever, ulcerative endocarditis.

Amongst other organisms which have been met with in the blood are the plasmodium malariae, bacillus of typhoid, bacillus of glanders, and bacillus of tetanus

THE SPUTUM.

GENERAL CHARACTERS AND COMPOSITION.

MUCOID, muco-purulent, purulent, watery, serous, sero-sanguinolent.

Aërated ; non-aërated.

Thin, fluid. Thick, viscid, tenacious.

Homogeneous ; nummulated.

Colourless, yellowish, greenish, bile-stained, blood-stained, rusty, pigmented.

Certain of the characters of the sputa best observed when they are suspended in water. "Nummulation" is thus well shown. Also the presence of membranous shreds, bronchial casts, blood-clots, and other solid constituents.

For they may contain :—

Cheesy and calcareous masses.

Particles of coal and other dust.

Fibrinous casts in acute pneumonia and croupous bronchitis (*v.* p. 16).

Membranous exudations in laryngo-tracheal diphtheria.

Hydatid membrane.

Foreign matter, as cotton fibre, hairs, food-particles, etc.

In *acute bronchitis*, the sputum is at first aërated, mucoid, often pigmented, later muco-purulent.

In *chronic bronchitis*, muco-purulent, pigmented ; or purulent and nummular, and perhaps non-aërated.

In *plastic bronchitis*, mucoid, perhaps blood-streaked, containing bronchial fibrinous casts.

In *bronchiectasis*, profuse, purulent, foetid.

In *phthisis* (a) *early*, mucoid, streaked with blood or pus ; (b) *advanced*, purulent, nummular.

In *acute pneumonia*, at first scanty, viscid, rusty, orange-coloured, blood-stained or of "prune-juice" character ; afterwards greyish, muco-purulent.

In *pulmonary gangrene*, very foetid, greenish or greenish-black, separating, on standing, into three layers—an upper, frothy and greenish ; middle, liquid, serous ; and lower, a thin brownish sediment.

In *pulmonary abscess*, in *empyema* discharging through a bronchus, or other abscess opening into lung, the sputa may consist of pure pus, which may or may not be foetid.

In *pulmonary œdema*, copious, thin, serous or sero-sanguinolent, often non-aërated.

In *acute pulmonary congestion*, aërated, intimately mixed with bright blood ; *chronic congestion*, markedly blood-stained.

In *pulmonary embolism*, pure blood or of "prune-juice" character.

In *cancer of lung*, sanguinolent.

HÆMOPTYSIS.

Blood may occur in the sputum from the rupture of vessels directly connected with lungs and bronchi ; or from other sources, as epistaxis, bleeding from gums, pharynx,

etc. In the latter class, distinguished as *spurious* hæmoptysis, the sputa are very little else than blood-stained saliva, seldom of large amount, and forming a thin reddish or blackish-red fluid. *True* hæmoptysis may occur in (1) ulceration of larynx ; (2) early phthisis, the blood being florid, of variable amount, sometimes only in streaks ; (3) advanced phthisis, from rupture of a pulmonary aneurism, when the blood is often in large amount and dark ; (4) plastic bronchitis ; (5) pulmonary congestion ; (6) pulmonary embolism,—both (5) and (6) occurring especially in association with mitral disease ; (7) hydatid of lung ; (8) cancer of lung ; and (9) aneurism (of aorta) rupturing into trachea or bronchus.

MICROSCOPICAL EXAMINATION.

Take up by pointed glass rod or forceps a small portion and place it on a slide ; press down cover slip. Examine first without addition of reagents ; then add drop of dilute acetic acid ; and to another specimen some liquor potassæ. Iodine or carmine may be added to stain cells.

1. **Mucus corpuscles, leucocytes, pus corpuscles**, often fattily degenerated.

2. **Red blood corpuscles.**

3. **Epithelia.**

(a) Squamous—buccal.

(b) Ciliated—from nose or trachea.

(c) Columnar—from trachea or bronchi.

(d) Spheroidal or elliptical, finely granular, often containing granules of black pigment—from pulmonary alveoli; generally contain oil globules and myeline masses.

[In cases of malignant disease of larynx or lung some cancer cells may occur in the sputum, but they are seldom distinctive. The most characteristic are the cell-nests of squamous epithelioma from larynx.]

[Nuclei brought into view by staining or by addition of acetic acid.]

4. **Elastic tissue.**

May be detected by adding caustic soda or potash to specimen; or more effectually by collecting large quantity of sputum, and boiling it with equal amount of solution of caustic soda, until it has lost viscidty (avoid over-boiling); pour mixture into conical glass, and add 4 or 5 times quantity of cold distilled water. Set aside, and after 2 or 3 hours examine deposit.

Recognise elastic tissue by its curling fibres with dark borders. (In phthisis the fibres may retain outlines of alveoli.)

The detection of elastic tissue, especially if it retain

alveolar arrangement, is almost pathognomonic of pulmonary disorganisation. Fragments of such tissue are, however, also met with in chronic laryngitis, bronchitis, bronchiectasis, and chronic pneumonia.

[N.B.—Cotton fibres, etc., not to be mistaken for elastic fibres.]

5. **White fibrous tissue.**

(Seldom occurs, except in cases of abscess and pulmonary gangrene.)

6. **Curschmann's spirals.**

Consist mostly of whitish central thread covered by fine twisted fibrils, often entangling epithelial elements.

These curious constituents of sputa are often sufficiently large to be visible to the unaided eye. They are of frequent occurrence, especially in capillary bronchitis and asthma; and may be associated with Charcot-Leyden crystals (*q.v.*). They are believed to be formed in the finest bronchioles.

7. **Bronchial tube casts.**

Composed of fibrinous or croupous exudation; distinguished by dichotomous division corresponding to bronchial ramifications.

Small fibrinous casts may sometimes be detected in the rusty expectoration of *acute pneumonia*. Larger forms, sometimes much branched, and either solid or tubular, are characteristic of plastic bronchitis.

Shreds of membrane may be expectorated in diphtheria ; they are composed of fibrin entangling epithelia and leucocytes.

8. Corpora amylacea.

Rare ; met with in pulmonary hæmorrhage (Friedreich) and in gangrene.

9. Crystals.

(a) *Charcot-Leyden crystals*. — Colourless, pointed octahedra, insoluble in cold water, ether, alcohol, chloroform ; soluble in alkalies, mineral acids, hot water, acetic acid.

Met with in asthma (often with 6) and bronchitis, acute and chronic.

Similar crystals were discovered in leukhæmic blood by Charcot they also occur in semen.

(b) *Hæmatoidin*.—Long rhomboids or needles of ruby-red colour.

May occur after hæmoptysis, and in chronic congestion from heart disease.

(c) *Cholesterine*.—Highly refractile, rhombic plates, often with one angle cut out, as it were ; soluble in chloroform ; turning red with sulphuric acid.

In phthisis and abscess of lung.

(d) *Fat crystals* (stearin, palmitin).—Very

pointed, acicular, in bundles ; soluble in ether and hot alcohol, insoluble in water and acids.

In putrid bronchitis, bronchiectasis, pulmonary gangrene.

(e) *Tyrosin*, as masses of acicular crystals. (In same conditions as *d*.)

(f) *Ammonio-magnesium phosphate*, and *oxalate of lime* occasionally.

10. **Fungi.**

A. NON-PATHOGENIC.

a. Moulds, as *oïdium albicans*, *aspergillus*.

b. Yeasts, as *torula*.

c. Bacteria (including *leptothrix buccalis*) and micrococci (including *sarcina pulmonis*).

B. PATHOGENIC.

a. Bacillus tuberculosis.—Small, slightly curved rods (measuring 1.5μ to 3.5μ), often containing spores (from 2 to 6), which give the bacilli a beaded appearance. For their detection special selective staining is required.

The presence of these bacilli in the sputum is diagnostic of a tubercular lesion in the air-passages or lungs. In acute miliary tuberculosis, however, they may be so scanty as not to be detected in the sputa after repeated examination. They are especially abund-

ant in pneumonic phthisis, *i.e.*, where caseation and excavation are progressing rapidly. It is stated that abundance of bacilli with scanty expectoration indicates a limited lesion. In a given case the numbers of bacilli met with may vary from day to day; and not much reliance can be placed upon their relative abundance in respect to prognosis. Other clinical facts have more significance in this matter.

METHOD OF STAINING TUBERCLE BACILLI.*

1. Select opaque particles of sputum to size of a large pin's head.

2. Spread out an even layer by pressing between two cover-glasses, and sliding them apart.

3. Dry between fingers over flame, smeared side downwards.

4. Pass three times quickly through flame to fix albumen, etc.

5. Place 3 drops of Neelsen's solution on preparation, and warm till steam rises.

[N.B.—Take care not to burn or warm unevenly. Tilt about cover slips.]

6. Wash off excess of stain, and *decolorise in acid* (*i.e.*, either H_2SO_4 —25 p.c., or HNO_3

* Kindly furnished by Dr. Essex Wynter,

—33 p.c.), taking care to remove all stain. Test by frequent washing until it becomes a lavender tint. [Time, about 15 seconds.]

7. Wash off all acid thoroughly and put on one drop of methylene blue (concentrated watery solution). [Time, about 5 seconds.]

8. Wash off and dry in fingers over flame.

9. Mount in cedar oil (temporarily), or in xylol or balsam of Peru, or in Canada balsam.

Neelsen's solution :—Fuchsine, 1 part, dissolved in a 5 per cent. watery solution of carbolic acid, 100 parts ; alcohol, 10 parts.

By this method the bacilli are stained of a *red* colour ; pus cells, etc., blue.

ANOTHER METHOD.

1. Select opaque particles of sputum to size of a large pin's head.

2. Spread out an even layer by pressing between two cover-glasses, and sliding them apart.

3. Dry between fingers over flame, smeared side downwards.

4. Pass three times quickly through flame to fix albumen, etc,

5. Float cover-glass on surface of few drops of Weigert-Ehrlich solution in watch glass.

6. Warm over flame till vapour is seen to rise from surface.

7. Remove specimen from watch glass and allow it to cool.

8. Wash it in nitric acid (1 in 4).

9. Then in distilled water.

10. Then in weak alcohol.

11. Dry and mount in Canada balsam.

Weigert-Ehrlich solution:—Saturated aqueous solution of aniline, 100 c.c. ; saturated alcoholic solution of fuchsine, 10 c.c.

By this method also the bacilli are stained of a bright red ; and the specimen may, if desired, be counter-stained a blue colour by immersion in methylene blue solution. Or instead of fuchsine, methyl-violet or gentian-violet (saturated alcoholic solution) may be used in the primary stain ; in which case the bacilli have a *blue* colour ; and the specimen may be counter-stained by vesuvin or Bismarck-brown (filtered aqueous solution).

b. Diplococcus pneumoniae. Specimens prepared as above, but without decolorisation by nitric acid. Or the cover-glass preparation of

dried sputum allowed to float on surface of gentian-violet solution and aniline water for 5 minutes, then treated with solution of iodine (1 part) in iodide of potassium (2 parts) and water (300 parts). Wash in water and alcohol, dry, and mount in xylol. The diplococcus is characterised by a clear capsule.

[Other micro-organisms in pneumonic sputa are the bacillus pneumoniae (Friedlander), streptococci and staphylococci.]

c. Actinomyces or *Ray-fungus*. Of rare occurrence in human subject, composed of clavate-shaped bodies radially arranged.

Masses of the fungus are visible to the naked eye as bright yellow grains mingled with the expectorated pus. It may be stained in the same manner as *b*.

11. Infusoria.

Monas and *Cercomonas* (met with in pulmonary gangrene).

12. Vermes.

a. Echinococcus. Hydatid membrane (laminated) or hooklets.

b. Bilharzia. Ova—spicule at one extremity. (This parasite has been found in the lung.)

THE VOMIT.*

Reaction.—Acidity may be due to normal gastric juice (HCl mainly) or to products of fermentation (acetic, lactic, butyric acids chiefly). Reaction may be neutral, or even alkaline (*e.g.*, watery vomit, which is largely due to saliva).

Characters.—May be watery, mucous, sanguinolent, biliary, purulent, fæcal.

May consist largely of:—

1. **Water** or saliva; thin, colourless, clear fluid (as in “water-brash,” “morning sickness,” “hysterical” vomiting).

2. **Mucus**, mingled with gastric juice (as in gastric catarrh).

3. **Ingesta**, in variable amount, and either quite undigested or semi-digested. (Note especially masses of casein from curdled milk.)

4. **Fermentation-products** (sarcinous vomit) often of frothy, “yeasty” character and sour odour. (Best seen in cases of dilated stomach from pyloric stricture, where vomiting occurs at long intervals and in large amount.)

* Exclusive of cases of poisoning.

5. **Bile**, frequently mingled in small amount with mucus and gastric juice. This "bilious vomiting" has mostly a bright green colour (which may deepen on exposure), due to production of biliverdin by action of the acids of gastric juice. (In "cerebral" vomiting, in acute peritonitis, and other conditions where vomiting is repeated frequently and in small amount.)

6. **Blood**, in variable quantity. If copious hæmorrhage may then have blackish clots and much fluid blood, but slightly altered; or if it has remained long enough in the stomach to be acted on by gastric juice (or in the case of mineral acid poisons, when this change is at once effected), the vomit has the characteristic "coffee-ground" colour due to action of acid on the hæmatin of blood.

HÆMATEMESIS.

Blood in vomit may not be derived directly from the stomach, but may come from epistaxis, or from pharynx or œsophagus, and thence enter the stomach to be ejected subsequently. Or in larger amount may enter from rupture of an aneurism into œsophagus. A frequent source of gastric hæmorrhage, sometimes very copious, is portal obstruction (cirrhosis of liver); but equally

common sources are gastric ulcer and cancer. As a rule, the hæmorrhage is more profuse, and the vomit therefore composed more of unaltered blood in ulcer than in cancer, where the "coffee-ground" character is more frequent.

7. **Fæcal matter** gives a yellowish, greenish, or brownish colour to vomit, and a penetrating odour. (Significant of intestinal obstruction from any cause. Also in the rarer case of a gastro-colic fistula.)

8. **Pus**—a rare concomitant (implies rupture of an abscess into the stomach).

The character of the vomit depends on the predominance of one or other of the above constituents.

EXAMINATION.

1. Note quantity ; character ; reaction.

2. Free HCl, if in large amount, causes decoloration of methyl-aniline violet (aqueous solution) ; and gives yellow or brown tint to "emerald green."

Filtering paper soaked in solution of Congo-red may be used to detect the presence of free acid, which changes the colour to blue, the depth of tint obtained being proportionate to the amount of HCl present.

There are several other tests for the detection of free HCl. The most delicate is said to be that with *phloroglucin-vanillin* (phloroglucin 3, vanillin 1, absolute alcohol 90 parts). One or two drops warmed in porcelain dish with filtered vomit. Deep-red tint if free HCl present ; brown or brownish-red deposit if absent. (Vierordt.)

[There is excess of HCl in most cases of gastric ulcer, but a partial or total deficiency in cases of cancer.]

3. Lactic acid deepens the tint of dilute solution of ferric chloride.

4. **Microscopical Examination.**

(i.) Blood corpuscles—white and red—altered and swollen.

(ii.) Blood-pigment in granules.

(iii.) Squamous and columnar epithelium.

Food residues, as:—

(iv.) Muscle-fibres—swollen, variously dis-integrated, often deep yellow colour, and striation well marked.

(v.) Oil globules.

(vi.) Fat crystals (needle-shaped).

(vii.) Connective-tissue fibres, elastic and white.

(viii.) Starch granules:—note markings, re-fractile appearance, and blue coloration on addition of iodine.

(ix.) Vegetable cells (note chlorophyll) and jointed fibres (not to be mistaken for foreign matter).

Fungi, as :—

(x.) Moulds.

(xi.) Yeasts, notably *Torula cerevisiæ*; oval and spherical spores, with perhaps some mycelium. Also other kinds.

(xii.) Bacteria, micrococci, especially the *Sarcina ventriculi*, recognised by large size, “wool-pack” appearance, and yellowish tint.

THE FÆCES.

Consistence.—Solid (scybalous), semi-solid, pultaceous, loose, mucoid, slimy, fluid, watery.

In constipation the motions are hard, dry, often in small rounded masses. In the various forms of diarrhoea their consistence varies from semi-solid, loose motions, to watery stools, the latter being also produced by hydragogue purgatives. In catarrhal enteritis, often slimy and mucoid; also in cancer of rectum. In the diarrhoea of typhoid fever, the stools may have a characteristic appearance, compared to pea-soup, being thin and watery, with much drab-coloured sediment. In cholera they are very watery, and contain flakes of epithelium (rice-water stools).

Amount.—Scanty or copious; if solid, note the size of motion and its calibre.

Flattening of solid motions may signify stricture of colon (*e.g.*, sigmoid) or rectum.

Reaction.—Alkaline or acid.

Normally slightly alkaline, but the reaction depends on quality of food as well as on fermentation changes in intestine. Pronounced alkalinity may be due to albuminous disintegration; it is found in certain forms of dyspepsia, and in typhoid fever. In acute enteritis, and especially infantile diarrhoea, the reaction is acid.

Colour.—Dark brown, bright yellow, pale yellow or drab, putty-like and white, greenish or black. Varies with degree of admixture with bile, with alterations in the bilirubin after its excretion, with presence of blood, with kind of food ingested, and of drugs that may be administered.

Examples.—Stools may be drab-coloured or putty-white in obstructive jaundice or deficient bile formation. Greenish in infantile diarrhoea (due to acidity and conversion of bilirubin into biliverdin? or to fermentative changes?). Also often greenish after taking calomel. They are blackened in cases of hæmorrhage high up in the intestine (*melæna*), from formation of sulphide of iron. Also from similar change—the stools are black when salts of iron, bismuth, or manganese are being

taken. Blood—if unaltered (*i.e.*, in copious hæmorrhage from ulceration of ileum or colon, or from rectum)—and pus give their characteristic colour to the motions. The fæces may be of bright yellow tint, if rhubarb, senna, or santonin, be taken.

Odour.

A highly offensive odour developed under various conditions, mostly attributable to fermentation changes in albuminous materials; when bile is deficient, this character usually obtains.

Constituents.—Masses of undigested food, *e.g.*, casein from milk; vegetable matter, grape-skins, orange-pulp, currants, seeds, fruit-stones, etc.

Foreign bodies—accidentally swallowed.

Excess of fat.

Observed in cases of pancreatic disease and obstructive jaundice.

Shreds or complete “casts” of false membrane, and of epithelium.

As in membranous enteritis, and also in chronic ulceration of bowel (*e.g.*, tubercular ulceration).

Enteroliths.

Gall stones and biliary concretions.

The search for these should be carefully made by breaking up the motion in water and straining through muslin,

Intestinal worms.

The presence of these parasites may be diagnosed by the detection of their ova in the fæces on microscopical examination (*vide* p. 33); but the worm itself, or in the case of tape-worms, its proglottides, are sufficiently large to be seen by the unaided eye. An exception may perhaps be made in the case of the trichina, which is the smallest of these entozoa. The leading characters of the chief varieties are as follows:—

Tænia mediocanellata—fully 4 metres in length, often more. The head (1·5 to 2 mm.) with central groove or depression, and furnished with 4 suckers, generally surrounded by black pigment. No hooklets. The ripe segments or proglottides, which are passed in the motions, are opaque, white, oblong (measuring about 18 mm. by 5 mm.); the genital pore projects from one margin, and the uterus, filled with ova, is remarkably branched.

Scolex stage passed in the ox.

This is the commonest tapeworm in this country.

Tænia solium—attains less length than the *T. mediocanellata*. Its head (about 1 mm.) presents four lateral suckers, and bears anteriorly a rostellum around which is placed a double row of hooklets, about 26 in all. The ripe proglottis, narrower than preceding, contains a uterus, which in the much smaller number and greater width of its branches contrasts markedly with that of *T. m.* The genital pore is lateral.

Scolex stage in the pig.

Common in Germany.

Bothriocephalus latus—from 5 to 8 metres in length. The head (2·5 mm. by 1 mm.) is elongated, with rounded end, and provided with a groove passing from before backwards. The segments are much broader in proportion to length than in the *Tænia*, the width increasing until near the terminal extremity. The genital pore is placed on the surface of each segment, and the uterus has a rosetted appearance and does not fill the segment.

Larval form in river fish, *e.g.*, pike.

This form of tapeworm chiefly met with in North Germany, Finland, and Switzerland.

In the case of a Finn in the Middlesex Hospital (1891) the intestine contained no fewer than 14 of these worms.

Ascaris lumbricoides—the largest intestinal nematode, the adult male measuring about 250 mm., and female 400 mm. The ordinary "round-worm" infesting small intestine (of children especially), seldom solitary; sometimes 5 or 6 present.

Oxyuris vermicularis or threadworm; males, 2·5 to 4 mm. in length; females, 10 to 12 mm., white in colour, and posterior extremity spiculated. Its habitat is the rectum and descending colon.

Tricocephalus dispar or whipworm, distinguished by the filamentous character of its anterior extremity, contrasting with the rest of the body. Measures 40 to 50 mm. in length. Infests especially the cæcum.

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This parasite has been found in great abundance in cases of beri-beri or "tropical anæmia."

Trichina spiralis—found in intestine in the adult sexually mature form, from 1.5 to 3 mm. in length.

Anchylostoma duodenale—males smaller (6-10 mm.) than females (12-18 mm.). Head bears a protruding mouth furnished with teeth, whereby it wounds the mucous membrane, and may cause intense, even fatal anæmia.

Anguillula.—Two forms (*intestinalis* and *stercoralis*) have been met with; they are smaller than *Anchylostoma*, which they somewhat resemble.

Microscopical Examination.

1. Intestinal products.

- a. Epithelial cells, mostly columnar, bile stained.
- b. Red blood corpuscles and blood pigment.
- c. Leucocytes. Pus corpuscles.
- d. Flakes and shreds of fibrin (membranous enteritis).

2. Food residues.

- a. Muscle fibres, yellow stained.
- b. Elastic and white fibrous tissue.
- c. Fat globules and crystals.
- d. Vegetable cells and fibres.
- e. Starch granules.
- f. Detritus.

3. Crystals of (*a*) hæmatoidin; (*b*) cholesterol; (*c*) fatty acids; (*d*) lime salts, oxalates, carbonate, sulphate; (*e*) triple phosphate; (*f*) Charcot-Leyden crystals (*vide* "Sputum," p. 17).

4. Ova of intestinal worms.*

(*a*) *Tænia mediocanellata*.—Nearly spherical, with thick shell, striated radially; in size—0·035 mm. by 0·039 mm.

(*b*) *Tænia solium*.—Similar to (*a*), but slightly smaller (0·033 mm. by 0·032 mm.).

(*c*) *Bothriocephalus latus*.—Ovoidal (0·07 mm. by 0·045 mm.), and shell provided at one end with operculum. Coarse brown granules in interior.

(*d*) *Anchylostoma duodenale*.—Oval (0·05 mm. by 0·023 mm.), clear shell, with granular contents often showing cell-division.

[The importance of detection of these ova is sometimes great, the symptoms of anchylostomiasis being those of pernicious anæmia, which disappear on the expulsion of the parasite by anthelmintic remedies.]

(*e*) *Tricocephalus dispar*.—Characterised by a nodular swelling at each pole of the well-marked shell.

(*f*) *Oxyuris vermicularis*.—About 0·052 mm. long and half that in width; granular contents in which nucleus and nucleolus are visible.

* For characters of these parasites, see p. 30.

(g) *Ascaris lumbricoides*.—About 0·05 mm., surface covered with conical projections.

5. Certain forms of protozoic organisms, as monadinea, coccidia, *cercomonas intestinalis*, *amæba coli*.

6. Moulds, yeasts, bacteria, micrococci, and the following pathogenic micro-organisms.

a. Spirillum of cholera (comma bacillus of Koch).

b. Spirillum Finklerii (cholera nostras).

c. Bacillus tuberculosis.

d. Bacillus of typhoid.

The examination for these micro-organisms is made by means of cover-glass preparations, as in the case of the sputum.

THE URINE.

GENERAL AND PHYSICAL CHARACTERS.

Quantity.—Normal daily average for adults, 40 to 50 ounces.

Increased (polyuria) by excess of fluid ingesta, renal degeneration (granular and waxy kidney), nervous conditions (diabetes insipidus, hysteria). Also in convalescence from acute

disease; in recovery from acute nephritis; during absorption of fluid serous effusions; in cardiac disease after relief of dropsy.

Action of diuretics, as digitalis, nitrous ether, scoparium, juniper, acetate and nitrate of potash, copaiba, etc.

In diabetes mellitus.

Diminished by restriction of fluid ingesta and increased activity of sweat glands; in acute nephritis; fevers; certain nerve conditions, *e.g.*, hysteria.

Suppressed in acute and chronic nephritis, obstruction of ureters, etc.

Colour.

May be (according to Vogel's scale):—1. Pale yellow; 2. Bright yellow; 3. Yellow; 4. Reddish yellow; 5. Yellowish red; 6. Red; 7. Brownish-red; 8. Reddish-brown; 9. Brownish-black. Chief conditions are:—

a. As regards amount of urinary pigment (urobilin).

From pale, limpid, watery (as in diabetes insipidus, hysteria, granular kidney), to dark reddish-yellow (as in scanty loaded urine of acute febrile conditions, mitral disease, etc.).

b. From admixture with blood or blood-

colouring matter. From brownish tint to bright red.

c. From admixture with bile. A yellow-green tint, or dark olive-green and brown, depending on degree and duration of jaundice.

d. From admixture with chyle (chyluria). Milky-white.

e. Melanuria from pigment excreted in cases of melanotic sarcoma.* (For tests, *see* p. 48.)

f. From the action of drugs.

Carbolic acid, urine darkens, becoming almost black, after standing. So also kairin, antipyrin. Santonin gives saffron-yellow tint, which changes to red on addition of alkali. Rhubarb, brownish (if acid), or red (if alkaline). Senna, ditto.

* I am indebted to a former house physician, Mr. Panting, for observations on the urine in a case of secondary melanotic sarcoma of the liver under my care at the Middlesex Hospital (July—August, 1891). The urine was generally straw-coloured when first passed, becoming in a few hours of a dark brown (mahogany) tint, and later still, almost black. This change was apparently irrespective of exposure to light, and took place before putrefactive changes had set in.

Transparency.

Especially clear and bright if saccharine, or albuminous,—as in cases of granular kidney and lardaceous disease.

Urine containing albumen retains for a long time the froth on surface that results from shaking the fluid.

Turbidity.

May be due to presence of excess of (1) lithates (in cooling); (2) phosphates; (3) pus, epithelium; (4) mucus; (5) blood (smoky urine); (6) chyle (chyluria).

Odour.

Ammoniacal, from putrefactive fermentation. Acetone odour, in diabetic urine. [Special odours from drugs, *e.g.*, turpentine; or articles of diet, *e.g.*, asparagus.]

Specific Gravity.

Depends on relative proportion of solids to water, and especially urea. Normal—1015 to 1025.

[Rough estimate of percentage of solids obtained by multiplying the last two coefficients of the specific gravity by 2.33, the resultant representing so many parts per 1000—*e.g.*, specific gravity, 1020, $20 \times 2.33 = 46.6$

per 1000 or 4.66 per cent. of solids; again, specific gravity, 1036, $36 \times 2.33 = 83.88$ per 1000 or 8.4 per cent. Urea equivalent to about three-fourths of total quantity of solids.]*

Reaction.

Acid, neutral, alkaline.

Acidity due to acid salts (urates and phosphates). Influenced by diet, drugs, and fermentation. Ordinary fermentation associated with conversion of urea into carbonate of ammonia by micrococcus ureæ.

CHIEF SEDIMENTARY DEPOSITS.

Urates.:—Generally pigmented (pinkish) because they carry down pigment with them. Are deposited on urine cooling, and can be readily dissolved by warming it.

Phosphates.:—Generally in pale urine, forming white feathery deposit, insoluble by heat, soluble in nitric acid. The alkaline phosphates increase as urine ferments, when also ammonium urate is formed.

Uric acid.:—Scanty, but characteristic; as fine red dust or sand, it constitutes “gravel.”

* See Percentage Table, p. 64.

Oxalates.:—Recognised by bright crystalline character.

Pus.:—White deposit.

Blood.:—Generally forms a dirty reddish-brown deposit.

QUALITATIVE ANALYSIS.

1. **Urates**.—A deposit soluble on heating.
2. **Phosphates**.—Precipitated by heat, soluble on addition of acid.
3. **Uric acid**.—The murexide test :—Place a few grains on porcelain dish, add drop of HNO_3 , apply heat, and when nearly dry, expose to fumes of NH_3 ; a crimson colour developed where the NH_3 in contact.
4. **Sulphates**.—Precipitated by baryta water.
5. **Chlorides**.—Precipitated by nitrate of silver (previously add HNO_3).
6. **Urea**.—Concentrate the urine by boiling, add HNO_3 , crystals of urea nitrate formed.
7. **Indican**.—Add carefully some HCl so as to form stratum below urine. At line of junction a deep blue or almost black tint developed, according to amount of indican present. Or more delicately with further addition of calcic

hypochlorite ; and the separated indigo may be dissolved out in chloroform.

Urine normally contains some indican, but such an excess of this substance as to give a marked reaction is usually only to be found in disease. It is especially abundant in intestinal obstruction, and more so in the acute than in the chronic forms ; but it also occurs in cancer of the stomach, peritonitis (acute and chronic), and in wasting diseases (*e.g.*, phthisis).

Closely allied to the indican reaction is the deep red tint obtainable (also in intestinal derangements) on boiling with nitric acid, which changes to yellow on further addition of the acid. The red tint can be regained by carefully neutralising with ammonia or sodic carbonate.

8. Ehrlich's Diazo reaction.—For this colour test the following solutions are required :—

- | | |
|----------------------------|------------|
| A. Sulphanilic acid . . . | 1 part. |
| Nitric acid | 2 parts. |
| Distilled water | 100 ,, |
| B. Nitrite of sodium . . . | 1 part. |
| Distilled water | 200 parts. |

Shortly before use mix 100 c.c. of (A) with 2·5 c.c. of (B).

About 10 cub. c.c. of this mixture is added to an equal amount of urine in a test-tube. The tube is now shaken, and a few drops

of liq. ammoniæ are added, when the fluid and the foam on its surface assume a bright red tint.

This reaction is obtained in the urine of typhoid fever (according to Ehrlich, as soon as the middle of the first week), also in that of measles, and sometimes even in pneumonia and phthisis. Although of some value in the early diagnosis of typhoid, it is said to be present in acute tuberculosis also.

9. **Albumen** (serum).

Is coagulated by :—

a. Heat—*i.e.*, boiling in presence of excess of acid (acetic or a few drops of citric acid).

b. Nitric acid, added in the cold. Form stratum of urine on surface of the acid in test tube. Not to be mistaken for crystalline deposits of urates or nitrate of urea; or the cloudiness produced by the acid in urine or patients taking copaiba.

c. Nitric acid (1 part) mixed with saturated solution of sulphate of magnesium (5 parts).

d. Picric acid. Precipitate rendered more evident on boiling, and thus distinguished from peptones.

e. Ferrocyanide of potassium in acid urine. (This secured by addition of citric acid.)

f. Tungstate of soda.

g. Trichloracetic acid very delicate for slight traces of albumen.

10. **Peptones.**

Not coagulated by heat.

Peptones give with picric acid alone a white precipitate soluble on boiling, and reappearing as solution cools.

To mixture of urine and liquor potassæ add small quantity of solution of cupric sulphate, which gives a rosy-red colour, turning to deep red and yellow with picric acid.

[This, the biuret test, is available for other albumens, but with them the colour is more of a violet tint.]

Peptonuria has been shown (v. Jaksch) to occur especially in cases of extensive purulent effusions, *e.g.*, suppurative peritonitis. It has also been met with in ulceration of the gastro-intestinal tract, in cancer of the stomach, and in the later stages of typhoid fever.

11. **Globulin and paraglobulin.**

Coagulated by heat; may be precipitated by sulphate of magnesium (saturated solution); and separated from serum-albumen by filtration, when the precipitate may be re-dissolved in water. Globulin may also be

precipitated from urine made alkaline by ammonia, and filtered, by addition of sulphate of ammonia. (*Kander.*)

12. **Hæmoglobin.**

Mix a few drops of (fresh) Tinct. Guaiaci with the urine and then pour in some ozonic ether. A deep blue tint at once develops at line of junction.

Or pour a little urine on white bibulous paper and then add the guaiacum and ether.

The chief fallacy in this test is the reaction yielded by the same agents in the urine of patients taking iodide of potassium. The colour in this case is, however, more of a greenish-blue tint, and is seldom developed with the rapidity that is seen when even a very small amount of blood colouring matter is present.

Hæmoglobinuria to such an extent as to give the urine a deep red or reddish-black tint, is seen in the affection "paroxysmal hæmoglobinuria." Dr. Mahomed found hæmoglobin before the appearance of blood in scarlatinal nephritis.

13. **Blood.**

Same test as (12). Another test is the dirty reddish-brown flocculent precipitate obtained on boiling the urine with liq. potassæ.

The microscopical test (*q.v.*) is of course

far more certain, and should never be omitted. Or the spectroscope may be employed.

HÆMATURIA.

Hæmaturia may be of renal or extra-renal origin, the former including the action on kidney of cantharides, turpentine, etc., acute nephritis, renal embolism, granular kidney, calculus, tuberculous pyelitis, and renal cancer; the latter, especially villous growths in bladder, cystitis, the *Bilharzia hæmatobia*, prostatic and urethral hæmorrhage.

N.B.—In women the menstrual blood may become mixed with the urine that is passed.

14. Pus.

The addition of equal parts of liq. potassæ (or sodæ) converts the deposit into a viscid glairy fluid. On boiling, the mixture gains in transparency, and its viscosity is evidenced by the entanglement of air-bubbles within it. For like reason purulent urine, if also ammoniacal, becomes “ropy.”

Confirm by microscopical examination (*q.v.*).

Pus is present in the urine, in urethritis (gonorrhœa), cystitis, pyelitis of all forms, also in renal abscess, or from the rupture into the urinary tract of abscesses situated external to it. In women leucorrhœal discharge may account for the deposit.

15. Mucus.

Flocculent; often as a filmy cloud floating in the urine. Is soluble in alkali, and can be re-precipitated on addition of acetic acid.

16. Sugar.

a. Moore's Test.—Add equal portion of liq. potassæ, and boil. Dark reddish-brown colour developed, with odour of caramel.

b. Trommer's Test.—Add a few drops of cupric sulphate solution, and then liq. potassæ until clear fluid obtained. Boil, get yellowish or orange-coloured precipitate (of cuprous oxide), the change of colour taking place before actual cooling occurs.

c. Fehling's Test.—Similar to (*b*), but the alkaline cupric solution previously prepared, consisting of cupric sulphate, sodio-potassic tartrate, and caustic soda. Red precipitate.

d. Böttiger's Test.—Take a few grains of carbonate of bismuth and boil with urine in presence of excess of alkali. The white powder becomes black (suboxide of bismuth).

e. Johnson's Test.—Boil with picric acid and then add potash. A deep red colour produced, so intense as to appear almost black until it is diluted.

f. Mulder's Test.—Solution of carbonate of soda added to urine; then solution of indigo-carmin. On heating the colour changes to yellow, and again becomes blue on shaking with air.

*g. Phenyl-Hydrazin Test.**—"Two parts of hydrochlorate of phenyl-hydrazin and three of acetate of soda are placed together in a test-tube containing 6-8 c.c. of urine. If the salts do not dissolve when the fluid is warmed a little water is added, and the test-tube containing the mixture is placed for 20-30 minutes in boiling water. After this it is taken out and put into a vessel containing cold water. If sugar be present, even in very moderate quantity, there forms directly a yellow crystalline deposit which may appear amorphous to the naked eye; but which when examined under the microscope is seen to contain yellow needles (of phenyl-glucosozon) detached and arranged in clusters."

h. Fermentation Test.—(See Quantitative Analysis.)

17. Acetone.

Add few drops of concentrated solution of sodium nitro-prusside and caustic soda. An evanescent red colour produced, which, on addition of acetic acid, will be replaced by a purple tint.

* Cited from von Jaksch (*Clin. Diagnosis*, p. 226), who considers it to be preferable to any other test.

Or precipitate of iodoform crystals obtained by treating the urine (containing acetone) with few drops of iodine, potassium iodide, and caustic potash.

[It may be well first to distil the urine, and to test the distillate as above.]

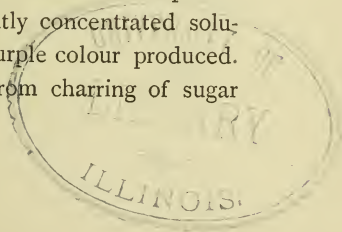
In some cases of diabetes a red colour is produced by addition of ferric chloride to the urine. This may be due to the presence of diacetic acid, which occurs with acetone.

18. **Bile pigment.**

Bilirubin converted into biliverdin by HNO_3 . Addition of this acid gives therefore a "play of colours" (red to grass-green). Test best seen by noticing effect of action of drop of acid on drop of urine placed on porcelain plate; or by soaking white bibulous paper in urine, and when dry placing drop of acid upon its surface.

19. **Bile acids.**

Pettenkofer's Test.—To mixture of sulphuric acid and urine, add gently concentrated solution of cane-sugar. A purple colour produced. (Test open to fallacy; from charring of sugar by acid.)



20. Melanin.

Although there seems to be some difference of opinion as to the precise nature of the pigment found in melanuria, the following tests are generally to be obtained. [They were invariably yielded by the urine of the case referred to in footnote on p. 36.]

Nitric acid causes the urine to assume a deep port-wine colour, which disappears on the addition of ammonia or other alkali.

A few drops of solution of ferric chloride causes a dirty olive-green precipitate, which still further darkens (becoming almost black) on continued addition of the reagent. Caustic potash dissolves the precipitate, and the mixture assumes a light brown colour.

Sulphuric acid produces a black precipitate.

21. Drugs.

Perchloride of iron gives purplish-coloured precipitate in urine containing :—(a) carbolic acid ; (b) salicylic acid ; (c) antipyrin ; (d) kairin, etc.

Copaiba gives cloudy precipitate on boiling, soluble in alcohol (not to be mistaken for albumen).

Tannin, dark green with perchloride of iron.

Santonin and rhubarb, red colour on addition of alkaline carbonate.

Iodine, liberated by HNO_3 or chlorine water. When shaken up with chloroform, the free iodine appears as red solution.

QUANTITATIVE ANALYSIS.

I. UREA.

A. Estimation by Mercuric Nitrate
(Liebig's method).

Reagents.

a. Volumetric solution of mercuric nitrate (of which 10 c.c. = 0.1 gramme of urea; or 1 c.c. = .01 grm., *i.e.* = 1 per cent.).

b. Baryta solution (2 vols. of baryta water and 1 of saturated solution of barium nitrate).

c. Carbonate of soda solution (20 grs. to the ounce).

Apparatus.

1. Centimetre measures.
2. Burette graduated in cubic centimetres.
3. Filters and filtering paper.
4. Beaker.
5. Porcelain plate.
6. Glass rod.

Process.

1. Take 40 c.c. of urine. [If albuminous, first boil and filter.]

2. Add 20 c.c. of (b) to precipitate sulphates and phosphates.

3. Filter.

4. Collect 15 c.c. of filtrate (*i.e.*, 10 c.c. of urine) in beaker or dish.

5. Fill burette with (a) and drop it into the filtered urine.

[Note when a definite precipitate forms, subtracting that amount, as indicating chlorides.]

6. After having used 10 c.c. of (a), place drops of (c) on porcelain plate, and after each addition of (a) to the urine, test for free mercury by mixing with (c). Cease as soon as yellow colour (*i.e.* yellow oxide) replaces white.

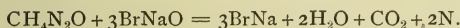
7. Then read off number of c.c. of (a) used before the yellow colour appears.

Example.—For No. 5, suppose 3 c.c. of (a) used before a definite precipitate appears. For No. 6, when 33 c.c. used, get yellow colour with carbonate of soda. Therefore $33 - 3 = 30$ c.c. of volumetric solution required to decompose whole of urea in 10 c.c. of urine. So that 30×0.01 grm. = 0.3 grm. in 10 c.c. of urine, or 3 grm. in 100 c.c., *i.e.*, 3 per cent.

It is easy then to calculate total amount of urea from the total amount of urine passed in 24 hours. (*v. p.* 64.)

B. Hypobromite method.

In this process, urea estimated by amount of nitrogen given off in decomposition of urea by hypobromite of soda, thus:—



The CO_2 is absorbed by the excess of alkali, so that all gas evolved is nitrogen.

Reagents.

Solution of sodic hypobromite freshly prepared.

[Take of bromine 1·3 c.c., and mix with caustic soda solution (1 in 25) 13·7 c.c., thus forming 15 c.c. of hypobromite solution.]

Apparatus.

Russell and West's.

1. A pipette graduated to 5 c.c.
2. A long tube with bulb and constriction into which glass rod protected by indiarubber may be inserted to act as stopper.
3. A trough to contain water, into floor of which the open mouth of (2) is fixed.
4. Gas receiver, a graduated tube closed at one end. Portion of this tube, of capacity

of 55 c.c., is divided into 30 equal parts. Now 55 c.c. of $N = 0.15$ gram. of urea, therefore each single division on the tube = $.005$ gram. of urea. Since the total quantity of urine used in the analysis amounts to 5 c.c., each division of the tube will indicate 0.1 per cent. of urea, and the whole thirty divisions 3 per cent.

Other more or less convenient forms of apparatus, all constructed on same principle, viz., to collect and measure the gas evolved by decomposing a given quantity of urine by hypobromite, are those of Gerrard, Doremus and Thursfield.

The process.

(a) Measure 5 c.c. of urine and place in bulb of tube (2), which can then be fitted into floor of trough.

(b) Fill bulb with water up to constriction, and then insert stopper firmly, and fill rest of tube with hypobromite solution.

(c) Fill trough with water and also the tube (4), which must now be inverted and moved over site of (2).

(d) Remove glass stopper; gas at once rises

and displaces water in (4). Note amount when all action ceased.

C. Hypochlorite method.

On similar principle as **B**, but solution of chlorinated soda employed instead of hypobromite.

Squibb's apparatus, usually employed for this, consists in two bottles of equal size, one of which (*A*) is filled with water, and communicates by an indiarubber tube with the other bottle (*B*), and by another tube with a beaker (*C*).

Four c.c. of urine in small test-tube placed in *B*, and then 40 c.c. of liq. sod. chloratæ are poured into *B*, which is then tightly corked and connection made with *A*. The bottle *B* is agitated so that the urine and hypochlorite freely mix. Gas is given off actively, displacing water from *A*, which is received in *C*. At close of experiment measure the water in *C*, which indicates amount of N given off.

Example.—Since 1 c.c. of N = 0.0027 grm. of urea, if 36 c.c. of water displaced by evolved gas, then $36 \times 0.0027 = 0.0972$ grm. of urea in 4 c.c. of urine, or 0.0243 grm. in 1 c.c., or 2.43 per cent.

II. SUGAR.

A. Estimation by Fehling's solution.

Fehling's solution.

Cupric sulphate, gr. $90\frac{1}{2}$.

Pot. tartrate, gr. 364.

Sol. sodic hydrate (sp. gr. 1.12) fl. oz. 4.

Water to fl. oz. 6.

Since this solution is of such strength that two hundred parts is reduced by one part of sugar, the total reduction of 200 grains of the solution is equivalent to 1 grain of sugar; or 10 cubic centimetres of solution to 0.05 gm. of sugar.

Apparatus.

1. Porcelain dish.
2. Spirit lamp or Bunsen burner.
3. A glass measure (grains or cubic centimetres).
4. Burette graduated in grain measures or cubic centimetres.
5. Glass rod.

Process.

Take some urine and dilute it with distilled water (1 in 10) and fill (3) with the mixture.

Measure 200 grains of Fehling's solution (or 10 c.c.), dilute it with water (equal parts or more), and boil.

Whilst boiling, drop in dilute urine from burette, stir up freely, and cease to add urine directly all blue colour discharged from the solution.

Then read off quantity of dilute urine used.

Example.—Suppose 1000 grain-measures of diluted urine ($=\frac{1000}{10}=100$ gr.-meas. of urine) required, would mean that 100 grs. of urine contain 1 gr. of sugar—*i.e.*, 1 per cent [or if 10 c.c. of Fehling decolorised by 10 c.c. of urine, since that means 0.05 grm. of sugar, this will amount to 0.5 per cent.].

N.B.—This test is less reliable when sugar is only present in small quantity, or if the urine contains excess of other solid constituents.

B. By fermentation.

Take two samples of urine, and place in bottles fitted with grooved corks. Into one add a small piece of German yeast. Keep both at warm temperature for 24 hours; then decant, and compare the specific gravity of each.

A loss of 1 degree of specific gravity is equivalent to 1 grain of sugar per fluid ounce of urine.

Suppose unfermented urine has specific gravity 1040, and fermented urine specific gravity 1008. Then the quantity of sugar = $40 - 8 = 32$ grains per ounce of urine.

[This result of course only approximate.]

In all cases, calculate not only the percentage, but the total quantity of sugar eliminated in 24 hours.

The observations should be made on sample of the whole urine passed in this time.

C. By Johnson's Picro-saccharimeter.

Apparatus.—One large boiling tube graduated up to 4 drachms from the bottom; 2 smaller tubes, one containing standard orange-red solution,* the other graduated so that each degree represents 0·1 grain sugar to the ounce.

Method.—To 1 drachm of urine add 30 minims of liquor potassæ, and 80 minims of a saturated solution of picric acid (aqueous), and dilute with water up to 4 drachms. Boil for 60 seconds, cool, and make up again with water to exactly 4 drachms. Compare with standard solution. If the tint corresponds

* Composed of : Liq. ferri perchlor. fort., ʒi. Ac. acet. glac., ʒiv. Liq. ammoniæ, m 100. Aq. destill. ad, ʒiv.

there is 1 grain of sugar to the ounce ; if lighter, less ; if darker, transfer to small graduated tube sufficient to occupy the first 10 divisions of the scale, and add water till tint corresponds ; the level on scale divided by 10 gives grains to ounce—*e.g.*, level on scale 35 = 3·5 grains.

This method gives consistent and reliable results, especially where sugar is present in small quantities : if exceeding 8 grains, first dilute with 9 of water and use 60 minims picric acid. Numbers on scale must not be divided at all, since they will now represent grains to the ounce.

III. ALBUMEN.

The most accurate method, viz., precipitation, drying and weighing the precipitate, too difficult for clinical estimation.

Esbach's method. A tube graduated to receive a certain quantity of urine, and so divided as to indicate, when all albumen is precipitated, the total quantity of grammes (of dried albumen) per litre, or in 0·x per cent.

The precipitant employed is :—

Picric acid	. . .	1 part.
Citric acid	. . .	2 parts.
Water		100

This is added in definite proportion (marked on tube), and the mixture allowed to stand for 24 hours, when the height to which the deposit reaches may be read off.

[If more albumen present than indicated by the marks on the tube, which do not exceed 0·7 per cent., the urine must first be diluted with an equal bulk of water.]

MICROSCOPICAL EXAMINATION OF URINARY DEPOSITS.

Set aside urine in conical glass, protected from dust, and when sediment well deposited remove by pipette to slide.

The deposits may be classified as (1) organic, and (2) inorganic.

Organic.

1. Blood corpuscles.

Appear mostly as clear discs or spheres; sometimes crenated; may enter urine from:—

a. Kidney, as in acute congestion, acute nephritis, granular kidney (sometimes); in hæmorrhage, from calculus, tubercle, cancer, or embolism. Also in purpura, scurvy, and other blood states.

b. Urinary tract, pelvis of kidney, ureter, bladder, urethra (including prostate).

c. In women, menstruation and uterine hæmorrhage may lead to admixture of blood with urine.

2. *Pus corpuscles.*

As granular spheres, to which addition of acetic acid brings tri-partite nucleus into view.

Source :—

a. Acute nephritis.

b. Tubercular and calculus pyelitis.

c. Cystitis.

d. Gonorrhœa, urethritis.

e. Abscess bursting into urinary tract.

f. Leucorrhœa.

3. *Epithelium.*

a. Renal—small, rounded, granular, with large nucleus.

b. Pelvic and urethral—tailed, pyriform.

c. Vesical and urethral—flattened, various shapes.

d. Vaginal—large, squamous.

4. *Renal tube casts.*

a. Epithelial, in acute nephritis, later stages.

b. Granular, in chronic renal disease mainly fine and coarse.

c. Fatty, in chronic nephritis, especially large white kidney.

d. Hyaline, large and small; small hyaline casts in acute nephritis, and large in granular kidney.

e. Blood in acute nephritis, renal embolisms.

f. Pus.'

Most casts have a fibrinous basis; their size depends on size of tubules whence they proceed, especially whether these are denuded or not of epithelial lining.

[N.B.—Do not mistake for casts :—mucous coagula and filaments, hairs, cotton fibre, or scratches on the glass slide.]

5. *Spermatozoa*.

6. *Bacteria and Micrococci*.

Occasionally *sarcinæ* occur, sometimes (but not invariably) in association with cystitis, or pyelitis (as in a case seen by writer in 1891), or after catheterisation. They are mostly somewhat smaller in size than *sarcina* ventriculi.

7. *Echinococcus*.

Shreds of hydatid membrane or small cysts may be passed in cases of hydatid of the kidney.

8. *Bilharzia hæmatobia*, ova of — oval in shape, spiked. These ova after a time may be observed to rupture and give issue to ciliated embryos.

Inorganic.

A. In Acid Urine.

1. Urates of potash and soda—amorphous fine granules.

2. Uric acid—reddish-brown or yellowish crystals, of various forms—4-sided tablets, 6-sided rhombs, lozenge-shaped, or ovoid, dumb-bell or barrel-shaped ; sometimes stellate aggregations. They are invariably coloured.

3. Oxalate of lime—as bright glistening small octahedra ; or (more rarely) dumb-bell or ovoid.

4. Leucin—yellowish-brown, striated, spheroids.

5. Tyrosin—silky, glistening, acicular crystals, in bundles.

6. Cholesterin—rectangular plates, often defective at one angle, soluble in ether.

7. Cystin—6-sided plates, insoluble in water and acetic acid, soluble in hydrochloric acid and in ammonia.

B. *In Alkaline Urine.*

1. Neutral phosphate of lime—fine amorphous granules.

2. Carbonate of lime, striated spheres.

3. Urate of ammonia—opaque, brownish coloured spheres, spiculated, sometimes dumb-bell crystals.

4. Phosphate of lime—crystals of “stellar” phosphate, *i.e.*, radiating bundles of oblong crystals (rare).

5. Phosphate of magnesia—flat elongated plates.

6. Phosphate of ammonia and magnesia, or “triple phosphate”—the usual form of phosphatic crystals in urine—mostly as large prisms with bevelled ends.

WEIGHTS AND MEASURES.

1 kilogramme	= 1000	gram.	= 15,432'3	grains.
1 gramme			= 15'432	„
1 decigramme	= 0'1	gram.	= 1'5432	„
1 centigramme	= 0'01	„	= 0'15432	„
1 metre	= 100	centimetres	= 39'37	inches.
1 decimetre	= 10	„	= 3'9	„
1 centimetre			= 0'39	„
1 millimetre	= 0'1	cm.	= 0'039	„
[1 micromillimetre(μ)	= 0'001	mm.	= 0'0003	„]
1 litre	= 1000	cub. centimetres	= 16,931	minims.
1 decilitre	= 100	„ „	= 1,693	„
1 centilitre	= 10	„ „	= 169'3	„
1 millilitre	= 1	„ „	= 16'9	„
(1 cub. centimetre of water at 40° C. weighs 1 gram.).				
1 pint	= 567'9	cub. centimetres.		
1 fl. oz.	= 28'4	„ „	(437'5	gr.-meas.)
1 fl. dr.	= 3'5	„ „		
1 minim	= 0'059	„ „		



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PERCENTAGE TABLE.

The percentage of urea, sugar, etc., being determined, it is required to calculate the total quantity excreted in 24 hours. In this country the urine is generally measured in fluid ounces, each ounce being equivalent to 437·5 grains.

OUNCES.	1	2	3	4	5	6	7	8	9	10
1 per cent.	grs. 4·375 8·75	grs. 8·75 17·5	grs. 13·125 26·25	grs. 17·5 35	grs. 21·875 43·75	grs. 26·25 52·5	grs. 30·625 61·25	grs. 35 70	grs. 39·375 78·75	grs. 43·75 87·5
2 "	13·125	26·25	39·375	52·5	65·625	78·75	91·875	105	118·125	131·25
3 "	17·5	35	52·5	70	87·5	105	122·5	140	157·5	175
4 "	21·875	43·75	65·625	87·5	109·375	131·25	153·125	175	196·875	218·75
5 "	26·25	52·5	78·75	105	131·25	157·5	183·75	210	236·25	262·5
6 "	30·625	61·25	91·875	122·5	153·125	183·75	214·375	245	275·625	306·25
7 "	35	70	105	140	175	210	245	280	315	350
8 "	39·375	78·75	118·125	157·5	196·875	236·25	275·625	315	354·375	393·75
9 "	43·75	87·5	131·25	175	218·75	262·5	306·25	350	393·75	437·5
10 "										

Example.—56 oz. of urine contain 2·8 per cent. of urea.
2 per cent. of 56 oz. = 437·5 grs.

2	"	"	"	"
0·8	"	"	"	"
0·8	"	"	"	"

Total 686·0 grs.

On the *metrical* system the calculation is simpler, since 1 cubic centimetre is equivalent to 1 gramme.
Example.—1500 c.c. of urine contain 3·2 per cent. of urea.

$15 \times 3 \cdot 2 = 48$ grammes of urea.